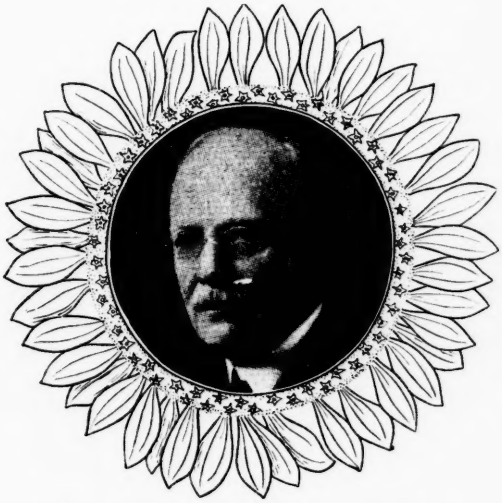
VOL. 10. OCTOBER, 1937. NO. 4.

Journal
OF THE
Kansas Entomological Society

PUBLICATION COMMITTEE
PAUL B. LAWSON, Editor, Lawrence
R. H. BEAMER, Lawrence R. H. PAINTER, Manhattan
DWIGHT ISELY, Fayetteville, Ark.



SAMUEL WENDELL WILLISTON
1852 - 1918

Entered as second-class matter December 31, 1927 at the Post-Office at McPherson, Kansas, under the Act of August 24, 1912.

Kansas Entomological Society

Vol. 10, No. 4. October, 1937.

THE SIXTH ANNUAL INSECT POPULATION SUMMARY OF KANSAS COVERING THE YEAR 1936*

ROGER C. SMITH (1) and E. G. KELLY (2)
Kansas State College, Manhattan, Kansas

This summary has been prepared with less questionnaire data at hand than has been the case with any of the previous five summaries (3). Returns from the July 1 questionnaire from 12 Entomologists, 18 Vocational agriculture teachers, 22 farmers and from 105 county agricultural agents, together with special survey data on grasshoppers during the outbreak, chinch bugs, and Hessian fly, records from the annual report of the junior author, and the insect pest survey reports of Prof. H. R. Bryson were used in preparing this summary. The October questionnaire was not sent out, through a misunderstanding. The summary maps are not sufficiently complete to justify publication, but they are preserved in the department files for consultation.

Summary of the Weather in Kansas for 1936 (4)

The year 1936 opened with severely cold weather and more snowfall than usual. A cold wave began on January 15 and continued with considerable sub-zero weather until February 21. This long, uninterrupted cold interval set a record for length in some parts of the state.

---

*Contribution No. 451 from the Department of Entomology.

This paper embodies some results obtained from investigations on Project No. 6 of the Kansas State Agricultural Experiment Station.

(1) Profesor of Entomology and Associate Entomologist, Kansas State Experiment Station. Absent on sabbatical leave May 1, 1936 to January 15, 1937. The questionnaires were summarized by Mr. Merle Dwd, an N. Y. A. employee.

(2) Extension Entomologist.

(3) The last two, for 1934 and 1935, have been published in the Transactions of the Kansas Academy of Science, Vols. 38 and 39.

(4) Summarized from the monthly reports of S. D. Flora, U. S. Department of Agriculture Weather Bureau, Climatological Data, Kansas Section, Vol. 50, Nos. 1 to 13, 1936.

In many cities and towns water pipes froze to a depth never before experienced.

March had less moisture than fell this month "for 50 years except one, making the first three months of 1936 the driest three-month period on record. The temperature has averaged milder only seven times in 50 years, but has had as much sunshine in only a few years." Dust storms were frequent in the western half of the state.

Drought conditions prevailed in April until rains on the 20th and 26th gave some temporary relief. The first week was one of the coldest on record. The minimum of 8 degrees F. in eastern Kansas and 2 degrees below in the western part did considerable damage to buds.

Heavy rains in May broke the damaging drought temporarily, particularly in the southwestern counties, and brought exceptionally fine growing weather over the entire state. Over the western third of the state it was the fourth wettest May in 50 years. Warmth and a normal amount of sunshine added to the favorable conditions. "Dust storms, which had been frequent and damaging in the western third for more than two years, ended abruptly on May 22."

June came nearly being a record-breaker for deficient rainfall and heat over Kansas. The month had more clear days than any other June for 50 years. Maximum temperature records for the month were broken in many parts of the state, and only the Junes of 1911 and 1933 had less rain.

"July was the hottest month on record except July, 1934, and broke all existing high temperature records in most places. It was the third driest July on record, and completed the driest seven-month period with which any year has begun in more than 50 years." The month brought disaster to the corn crop as one hot dry day succeeded another.

August was the hottest and third driest for the month that Kansas had experienced since the state-wide record was established in 1887. It made the summer of 1936 the driest on record and the hottest the state had ever experienced except in 1934. The eight month period it completed had less precipitation than the first eight months of any year on record. Corn generally had been damaged beyond recovery, and alfalfa had made

little or no growth.

During September more rain fell than in any September, except in 1900, for 50 years. The month was exceptionally warm but decidedly deficient in sunshine. Alfalfa that had not grown any for three or four months and grass in pastures began to grow in the eastern third.

The month of October began with good general rains and about normal sunshine. The month was pleasant and favorable for crop growth. Grass pastures were good.

November was sunshiny and pleasant with deficient moisture—the least, with four exceptions, in 50 years. Wheat showed the effect of dry weather.

December was generally mild, with more rainfall than usual. Christmas Day was the warmest in the history of the state. The rains in September, October, and December put sufficient moisture into the upper soil to carry wheat through the winter.

The summer of 1936 was the driest on record in Kansas as well as in six other mid-western states—Illinois, Missouri, Oklahoma, Nebraska, and the Dakotas. The good rains which fell in Kansas in early September came too late to improve the corn crop materially. However, they put the ground in good condition for fall plowing, fall seeding, and fall forage crops. The closing of August marked the end of one of the most disastrous crop seasons in the history of the state. The drought centered in Missouri, Kansas, and Oklahoma. New high records for temperatures were established, and rainfall was less than one-third normal for the three summer months.

Explanatory Notes on the More Striking Insect Activities in Kansas during 1936

Ants were more troublesome than usual during 1936, the yellow ants apparently increasing as a house and basement annoyance. The kafir ant or "thief ant," which sometimes damages planted seed of kafir and corn, was scarce.

The mound-building prairie ant was reported destructive to alfalfa at Oakley, Brewster, Gem, and Beverly during the summer but it was plentiful in all western areas. Pharaoh's ant was more abundant in 1936, and was rated at 2 in the eastern half and 1 (5) in the western

(5) An explanation of the scorings or rating of the populations on the basis of 0 to 5 is given in the previous summaries. The same concept value is used in this report.

half of the state.

Aphids of all kinds were scarce throughout the spring and summer. In the fall a few species became abundant.

The cucumber and melon aphids were plentiful in June and July, and required treatment in most eastern and middle counties.

Pea aphids were not found in alfalfa fields of the state until late April. Alfalfa made less growth than usual up to April because of the cool dry spring, but there was a good growth by this date in the southern part of the state.

A three-day pea aphid survey on April 23-26, 1936, west and east of Manhattan resulted in the finding of three pea aphids—two wingless ones south of Lawrence and one winged one. This insect has not been so scarce in Kansas since 1920. Moisture, temperature, and alfalfa growth were all favorable to a large outbreak and severe damage, but the species was presumably destroyed in the state by climate conditions and natural enemies during the summer and fall of 1935. Pea aphids were reported injuring garden peas at Ozawakie in June, and some were on peas in Pratt in June. They were rated at 1 in Area 9, 10c, and 1, (6) and at 0 for the rest of the state.

Corn leaf aphis became plentiful on soybeans in late August and September, being rated at 2 for most of the state.

There were few aphids on apple, plum and other fruit trees. Aphids on currants and gooseberries were scarce. They were plentiful on roses in May and June.

Green bugs (Toxoptera) were absent during 1936 in Kansas. This aphid was quite plentiful on fall-sown and volunteer oats in the late fall of 1935. The cold winter of

(6) The map of the crop areas of the state which are here referred to by number was included in the summary for 1931. Jour. Kan. Ent. Soc. 5(3):72, Fig. 1, 1932. The extension department now divides 6 into 6a which includes Cloud, Ottawa, Saline, Clay, Dickinson, and Marion counties; 6b which includes Rice, McPherson, Reno, Harvey, Kingman, Sedgwick, Harper and Sumner counties. Crop area 10 is divided into 10a consisting of Gove, Trego, Lane, Ness and Hodgeman counties; 10b of Stanton, Grant, Haskel, Gray, Ford, Morton, Stevens, Seward and Meade counties; and 10c of Clark, Comanche, and Barber counties.

1935-36 killed most all of them. There was hardly a specimen to be found in the fields in the early spring. It might also be said that there were no oat plants living. An infested spot of wheat about 10x20 feet was found in a wheat field at St. Marys on April 20. Mr. A. L. Clapp also reported this insect damaging barley near Iola.

Bagworms on evergreen and other trees. Eggs were plentiful during the winter of 1935-36 and hatched well in May. There was little damage, and by late summer and fall there seemed to be few full-grown bags on the trees. This pest was rated at 2 in the eastern half of the state.

Biting flies (Stomoxys and Haematobia) were plentiful in May but diminished as the dry weather progressed. By July there was hardly a fly to be seen. The flies returned in late September after the rains to cause much annoyance to livestock. The fine warm days in late September and early October were favorable to their development. There was no serious outbreak, but the flies were plentiful all over the state, being rated at 3 for most of the state.

Blister beetles of several species were abundant all over the state. The beetles attacked garden crops early in June and continued to attack the gardens until late October. Numerous coarctate larvae were found in grasshopper egg pods and others near their so-called egg beds while digging for eggs in the egg survey in October and November, 1935, as well as in the early spring of 1936. Judging from reports and observations made by the Extension Entomologist, some blister beetles occurred in "outbreak" numbers in July and August. The beetles were especially injurious to potatoes, tomatoes, and other garden crops, and also to soybeans and sweet clover. Blister beetles were rated at 5 for most of the state.

Horse bots. During the winter of 1935-36, numerous farmers treated horses for bots, but in Jackson County, horses were reported to have died as the result of bot larvae in their stomachs. The treatment did not include all the animals in a community, and therefore the flies were plentiful again in the late summer and fall. The adults were unusually numerous in September and October at wheat seeding time.

The nose bot was reported in five of the northwest-

ern counties, and the common bot was found in every county of the state. When the farmers began sowing wheat and getting lands ready for wheat-sowing, the bot flies seemed to appear in swarms. This insect was rated at 4 for the state.

Horse flies (Tabanids). There were not many of these flies this year. Usually these biting flies are numerous along the creeks and in the areas of swamps. Plans had been made to build some large fly traps, but there were not enough of the flies to demonstrate the trap. This insect was scored at 3 for areas along rivers and creeks and 1 for uplands.

Borers of several species continued to be major problems in fruit and shade trees. The flat-headed apple tree borers were abundant on apple and other trees throughout the state. The high infestation resulted from the weakened condition of the trees due to drought, heat, red spider, and aphid injuries during the last three years. They were observed in elm and apple trees in eastern Kansas in April and May. The borers were the source of numerous requests for aid from all parts of the state. They attacked apple, plum, peach, and cherry of the fruit trees, and elm, walnut, maple, hackberry, linden, oak, and many others of the shade trees.

The borers were more prevalent in 1936 than in any year known to the writers, many trees producing upwards of 200 larvae. The borer infestation may have been influenced by the moist May and dry June and July. They have been scored at 5 for most of the state.

Box elder bugs were exceptionally scarce during the fall and winter of 1935-36, and few were reported in the spring of 1936. Some were observed on stone or brick buildings as they emerged from hibernation. They were rated at 1 for the most of the state.

Canker worms emerged later in the spring than was the case during the two or three previous years. A few emerged about January 15 at Manhattan, but the main emergence began about February 23. Some banding was done in December and January. Warm weather, which began about February 22, brought out fall canker worms. The soil was dry and the weather too cold for early emergence. The prediction that the winter mortality of pupae would be high was correct, for there were few canker worm moths caught on the bands any time at any

place in the state. By April 20, very few canker worm moths had been caught on the bands at Manhattan. The emergence was the lightest for about five years. Apparently the hot dry summer of 1935 and other factors reduced the population to below normal. This condition prevailed over the state.

In the late fall of 1936, publicity on banding trees to catch the few remaining moths resulted in a widespread application of the remedy, and the catch was light even though December was moist and unusually warm. Indications are that the pest is at a low point in population. A rating of 1 in Areas 1, 2, 3, 5, and 6a, and 0 for the rest of the state has been given.

Cattle grubs were abundant in cattle in every county in the state during the winter of 1935-36. Numerous farmers removed the grubs by squeezing them out. Some reported removing as many as 385 grubs from one animal, and 80 to 90 were common in reports made by farmers and observations of the Extension Entomologist.

Cattle grub flies emerged early in spite of the cool dry spring. Cattle were observed running from the flies the latter part of February in Geary County. Many were also seen hiding in bushes along fences on April 14 in Dickinson County. The flies were observed chasing cattle in Jackson County on April 10, at Anthony, Manhattan, and Wellington on April 6, and in Bourbon County about the middle of May. These dates and locations indicate that the heel flies were out early and continued to be abroad well into May.

A survey of cattle by the Extension Entomologist and county agents in ten eastern and five central counties indicated the grubs in cattle in the fall of 1936 were not as numerous as in the fall of 1935. In fact, while locating some demonstrations in these counties it was difficult to find calves or cows with as many as 25 to 30 grubs in their backs, and most of the animals examined were practically free of the pest. The rating of 4 was given for most of the state.

Cattle lice, both chewing and sucking, were more plentiful and destructive during the spring of 1936 than for several years. Some cattle died in Geary and Pottawatomie Counties during January and February from heavy infestations of sucking lice. More requests for information for control of lice on cattle and horses reach-

ed the Department of Entomology than usual. The excessively cold weather during January and February made dipping or spraying operations dangerous and difficult.

Horses and cattle in Sumner, Harper, Pratt, Pawnee, and Reno Counties were reported heavily infested in the early spring. The long-nosed ox louse was plentiful in Harper County in early April. A rating of 4 was given for most of the state.

Cutworms. Army cutworms were exceptionally scarce during the spring all over the state. Mr. H. H. Walkden made a 1500-mile survey trip to the southwestern part of the state and found practically none. They were the scarcest for many years.

A three-day survey in Kansas April 14, 22, and 23 resulted in finding only two or three larvae. Many larvae of **Feltia subgothica** (the dingy cutworm) occurred, but this is a species of little economic importance. A field south of Junction City had an average population of four to the square foot, but no injury was done. The population of this species in northeastern Kansas was the largest in recent years, while the army cutworm had the smallest.

The pale western cutworm was abundant in scattered areas in central and western counties in May. Considerable wheat was damaged in Rush, Sheridan, Rawlins, Edwards, and Kiowa Counties. In early May they appeared in many wheat fields of western Kansas and especially in a small area of about five counties of which Barton County was the center.

The variegated cutworm appeared quite early in February and March in wheat fields in southern Kansas.

In the early fall the fall armyworm appeared in many wheat fields, feeding on the volunteer wheat. They seemed to disappear before the planted wheat came up. The rating for cutworms was set at 3 in Area 9, 7, 10a, and 11, and 1 for the rest of the state.

Chinch bugs. The chinch bug survey made in the fall of 1935 indicated there was a large population of bugs in about 38 to 40 counties including Harper, Harvey, and Clay as western boundaries. The spring survey, made in late April and in May, indicated there would be many bugs moving out of wheat and barley to corn in this area, and that creosote-cyanide barriers would be needed. The

winter survival was high from moderately large numbers over-wintering.

The bugs began moving from wheat and barley quite early in June on account of the very dry weather. Reports from 36 county agents in the eastern half of the state indicated 5,344 farmers built and maintained more than 2,500 miles of creosote-cyanide barriers to protect about 300,000 acres of corn and soybeans. They were rated at 5 in Areas 1, 2, 3, 4, 5, and the east half of 6b, and 1 in the west half of 6b, 9, 6a, and 8.

Codling Moths in the apple districts of the state built up from the low carry-over of last winter. A third brood was present this year, whereas only two broods were present last year.

Corn rootworm. This is a pest of major importance in the northern tier of counties, but it has been scarce during the last few years—probably on account of the drought.

Corn bill bugs were scarce in southern Kansas, where they usually occur.

Crickets. The common black field crickets were more numerous during the summer and fall than usual. They caused considerable annoyance in basements and houses. A heavy population was observed along a one-half mile stretch in Mitchell County on August 6. They were reported being a nuisance in a store in Osage County. The excessive heat and drought drove them to basements where they became a nuisance. Reports came from all parts of the state that crickets were in the basements of houses. They were rated at 2 in most of the state.

Cucumber beetle. The striped cucumber beetle was abundant early in May, and continued to be destructive until late June. The second generation appeared to be less numerous. The beetle attacked cucumbers, melons, and squash plants in all parts of the state, but seemed to cause more trouble in southeastern Kansas. They were rated 4 in most of the state.

The spotted cucumber beetles were not a pest on cucumbers in May and June, but were serious on garden flowers, especially zinnias, in September. They were rated 3 in gardens for most of the state.

Flea beetles were plentiful on radishes, turnips, and eggplant in April, but there was little damage. They were reported from the south-central counties.

House fly. This house pest was plentiful early in the spring, but became rather scarce as the weather turned dry. In the late fall, after the rains, the flies became annoying. They were rated at 3 for most of the state.

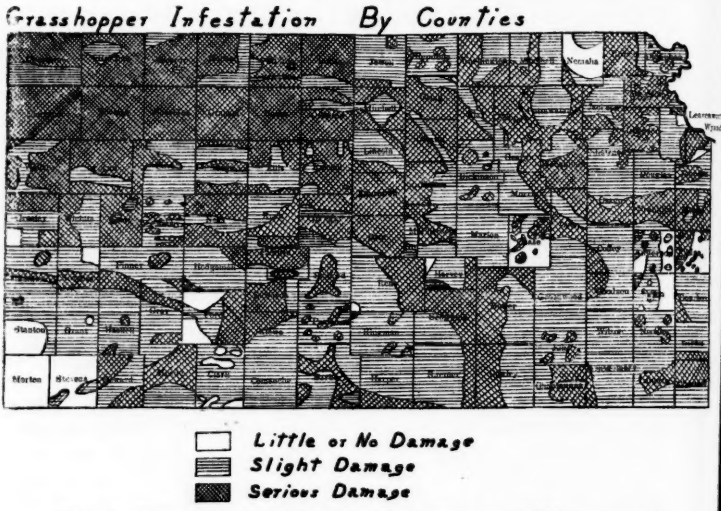


Fig. 1. The grasshopper outbreak in Kansas, 1936, as reported by 101 county agents in August. No one agrees completely with this map but in general it is correct. It shows the spotted nature of the outbreak.

Harlequin cabbage bug was reported from a few localities as being plentiful, but no serious damage was done by it.

Grasshoppers. The outstanding insect feature of 1936 was the unprecedented, statewide, outbreak of grasshoppers which has been designated by many observers as excelling the outbreaks of the early 70's. Grasshoppers have been scored at 5 for the entire state for the year, with the exception of Stanton, Morton, and Stevens counties which are scored at 3.

The grasshopper survey during the fall of 1935 revealed a larger number of eggs than usual. Estimates of needed bran mash for 1936 were made on the basis of a severe outbreak. The winter of 1935-36 was ideal for the eggs because cold weather continued from early De-

cember to the end of February without thaws. There were some good rains in May and the moisture brought out the young hoppers. The rains ceased in early June, the weather turned dry and hot. Grass and weeds either died or became unattractive so the hordes of young hoppers attacked cultivated crops.

In Riley county the young hoppers appeared about one month earlier than normal and went first into the wheat fields after which they attacked oats and then corn. Alfalfa, sweet clover, and other legumes were attacked continuously from the time of hatching and most eggs were laid in the fall in or around the margins of alfalfa fields. Corn over most of the state was severely attacked or destroyed. Weeds were quite generally fed upon. Kafir and other sorghums were not injured severely. Both the tops and bulbs of wild and cultivated onions were completely devoured in nearly all parts of the state. Pastures were benefitted by the removal of wild onions. Farmers observing the attractiveness of onions to hoppers have since used chopped onions and onion juice in baits. This is perhaps a first report of hoppers eating onions.

A special feature of the outbreak was the behavior of the hoppers with relation to the excessive heat. The surface of the soil was so hot that the hoppers spent most of their time up in the trees, the tops of weeds, corn, or in other tall plants. They did not come down to the ground to feed as the great majority of them usually do. This complicated the sowing of the poison mash. Some unsatisfactory results with the mash were due to the hoppers refusing to leave their high roosts. Mash was thrown up into the corn plants and it was common to find several dead hoppers with their heads buried in the axils of the leaves.

There were many reports to the effect that bran mash was not giving satisfactory control. Heavy kills were obtained but failures in controlling the grasshoppers were in some cases due to their refusal to come to the ground to feed, in others to migrations from adjacent fields, or to flights from more distant fields, and to the excessive heat which dried out the mash quickly. Some nurserymen made as many as 12 to 20 sowing of mash to protect their nurserystock. More than 550 alfalfa growers reported using hopperdozers and hopper catchers.

Their value in grasshopper control under conditions in Kansas in 1936 was demonstrated conclusively.

Prof. Wilbur reported that the differential grasshopper was the dominant species in the outbreak even in western Kansas. Dr. Woodruff reported that the red legged species was dominant around Lawrence. The migratory species was abundant, but the two lined ranked third.

The grasshoppers damaged or destroyed corn and alfalfa extensively. Some fields which were saved by hopper control methods were later rendered valueless by the extreme drought. Many trees, not only isolated shade trees and hedge rows, but varieties of woodland and park trees were defoliated. Many apple trees had severe foliage damage and even the next year's fruit buds were eaten as was shown by absence of bloom in some orchards during the spring of 1937. Many shade trees had the bark completely removed. In some cases the hoppers ate pits in the bark, and in other cases the bark was removed in large patches. Reports of damp clothes on the line being eaten by hoppers, of coats or other clothes being destroyed on the ground have been made.

Professor Dean observed the differential and migratory species fly as far as 5 miles to other fields. There were definite migrations from grasslands and wheat stubble to corn and alfalfa fields throughout the season. Heavy flights occurred into towns where gardens, trees and ornamental plantings were damaged.

A feature of the outbreak was the heavy parasitism by sarcophagid flies chiefly **Sarcophaga kellyi**. The flies first appeared in May but they were largely inactive during the hot, dry summer. They reappeared the latter part of August, when rains came, and destroyed large numbers of hoppers. Great numbers of the larvae and puparia were taken in the hopper catches at the college farm and reared to adults.

In most of the counties in northeast Kansas during the latter part of May, the fungus disease was present. Professor Dean observed young hoppers dying of the disease in many sections. If the rains had continued for two weeks in June, the disease might have brought about control.

Relatively few eggs were laid in the early fall compared to the number of hoppers present during the year.

Professor Wilbur found few eggs of grasshoppers in the survey conducted in September and October except in northeast Kansas. He believed that the weather was too hot for the development of the gonads or that there was insufficient nutritious food for the development of the eggs.

Another feature of the outbreak was that the large population of adults did practically no damage to fall sown wheat and alfalfa. Only wheat sown in August and early September for pasture was damaged by grasshoppers while wheat sown at the fly safe date escaped injury. Less than usual fall damage was done and not a single report of damage to young alfalfa was received. There was little or no injurious feeding after the first week of October.

The following sentence summaries were prepared by the extension entomologist and assist in portraying the extent and severity of the outbreak:

Alfalfa treated with a dozer in 61 counties—30.769 acres.

Soybeans treated with a dozer in 15 counties—648 acres.

Farmers in 79 counties bought 55,120 pounds crude arsenic.

County commissioners in 30 counties bought 82,000 pounds crude white arsenic.

Federal Government allotted 96,600 gallons sodium arsenite to Kansas.

County commissioners in 10 counties bought 2,905 gallons of sodium arsenite.

Wheat bran purchased by farmers in 93 counties—7,793,500 pounds.

Wheat bran purchased by county commissioners in 23 counties—1,788,700 lbs.

Molasses purchased by farmers in 79 counties—85,575 gallons.

Mixed bait furnished by Federal Government in 1934 left over in 9 counties—85,792 pounds.

Wheat slightly damaged in 69 counties—1,375,990 acres.

Wheat seriously damaged in 23 counties—82,426 acres (not harvested).

Oats slightly damaged in 61 counties—390,090 acres.

Oats seriously damaged in 18 counties—23,307 acres (not harvested)

Corn slightly damaged by grasshoppers in 75 counties—1,449,945 acres.

Corn seriously damaged by grasshoppers in 88 counties—1,471,155 acres.

Barley slightly damaged in 45 counties—132,445 acres.

Barley seriously damaged in 17 counties—11,982 acres (not harvested)

Orchards seriously damaged in 60 counties numbered 3,746.

Gardens seriously damaged in 95 counties numbered 83,848.

Alfalfa slightly damaged in 79 counties—341,095 acres.

Alfalfa seriously damaged in 73 counties—213,935 acres.

Osage orange hedge defoliated in 64 counties—15,277 miles.

Farmers using Federal sodium arsenite in 104 counties—42,487 (all except Norton).

Farmers using white arsenic furnished by county commissioners in 38 counties—18,500.

Farmers purchasing white arsenic or sodium arsenite in 88 counties—17,274.

Total number individual farmers using poison bait—54,-314.

Hessian fly. In the fall of 1935 the Hessian fly appeared to be building up in numbers. There were many heavily infested fields in the southern and central counties. Several thousand acres were so badly damaged by the fall infestation that the fields were planted to other crops in the spring of 1936. The number of flaxseeds on the plants in the spring indicated there would be a heavy infestation; however, something happened to the adults

or eggs in April, for after the hot dry days, during which time most of the adults were abroad, there were very few living maggots on the plants. The insect had suffered a severe reverse on account of hot dry weather, and the infestation in the stubble was even lighter than it was in 1935. In a small area centering in Geary and McPherson Counties there were more of them living than in the eastern counties. A few were found in all fields visited in Doniphan County the latter part of April.

The Hessian fly devastated nearly every field in southeastern Kansas which was planted before the fly-free date in the fall of 1935. As much as 66 per cent of the plants were infested in December at Iola. While many farmers ascribed the loss to winter killing, they learned that the fly caused the loss. The population was estimated at an average of 5 per plant.

Mr. F. E. Davidson reported April 20 only a light infestation of flies at Columbus, Kansas, in spite of the fact that much of the wheat was planted early. An area around Parsons for eight or ten miles was reported as heavily infested, as was also an area west from Erie towards Chanute, and then well over into Wilson County where the wheat was damaged rather badly by the fly.

The Hessian fly population in Dickinson to Cowley counties was almost wiped out by temperatures from 16 degrees F. to 20 degrees F. in early April. The pupa and adults were destroyed, leaving the wheat almost free. Remaining live plants made a good comeback after the rains the latter part of April and early May.

Adult flies were observed laying eggs, three to ten per leaf, in Jackson County April 13, and south to Wilson County during the next few days. The hot winds and dry weather that followed seemed to have prevented the eggs from hatching.

The fall infestation was also light in all eastern counties. They were rated at 2 in Areas 1, 2, 3, 4, and 5, and at 1 in Areas 6a and 6b.

Mites and Ticks

Brown mites occurred in a few spots of damaged wheat in the fields of the southwest counties. These spots were in fields where the stubble had not been covered. There were a few fields slightly damaged at the

edges by the mites moving from stubble into the fields as is a well-known habit of the chinch bug.

Mange mites on hogs. The hog mange was less troublesome this year than for many years.

Sheep scab mites. Kansas has been fairly free from sheep scab mites for several years. The Federal quarantine has been effective in keeping them out of the state.

Dermacentor nigrolineatus, a common and more or less harmless species of Texas tick, was taken in large numbers on a herd of cattle shipped to Lebo, Kansas from Texas in January. The tick was identified by Dr. F. C. Bishopp, who stated that this species of tick had been unable to establish itself in Kansas and more northern states, presumably because of the cold winters.

Spinose ear ticks were reported to be plentiful, especially in western Kansas, during the winter of 1935-36 and again in the fall of 1936. They were rated at 1 for the state.

.....

Screw worms were scarce this year due in a great measure to the Federal inspection of cattle coming into the state. The range or pasture cattle were watched very closely and protected. This pest was rated at 1 for the state.

Mosquitoes were exceptionally scarce in Kansas during the year. Some localities reported some annoyance from them, but not as much as usual. They were present about the first week in October, after almost a complete absence during the summer.

Negro bugs (Thyreocoria publicarius Germ.) Negro bugs were numerous this year, but apparently did not cause appreciable injury.

The onion plant bug (Labopidea allii Knight) damaged onions all over the state during May as was observed by R. H. Painter.

Rose curculio (Rhyncites bicolor). This insect was more abundant during 1936 than has been observed or recorded before at Manhattan. Cultivated roses were attacked.

Squash bugs appeared early. By August the young bugs were abundant and attacking squashes and pumpkins which had escaped the drought doing severe and widespread injury. They were rated at 3 for the state.

The common stalk borer (Papaipema nebris) was reported injuring tomatoes at Brookville and White City, corn at Leavenworth and Clyde, and potatoes at Mulberry. They were rated at 3 for the eastern half of the state.

The strawberry leaf roller (Ancylis comptana) was abundant in northeast Kansas in the vicinity of Troy and Wathena in June, and the strawberry saw fly **(Harpiphorus maculatus)** completely defoliated the plants on two farms at Wathena. The strawberry leaf roller was plentiful in May in Most eastern Kansas counties. They were rated at 2 for the eastern third of the state.

Termites swarmed in large numbers on May 2 following the excellent rains of April 30 and May 1 in eastern Kansas. Many requests for information about termite control were received, but this was in large part due to the activity of termite treating companies and the spread of information through radio and press about these pests. Numerous houses have been found to be infested, and more reports of living trees being infested than have ever before came to the notice of entomologists. Both large as well as small trees have been killed by termites. These insects have been rated at 4 for the state.

Mr. W. A. Talbott, Jr. of the Underhill Terminix Company of Wichita, a state-wide operator in termite control, reported to the authors, from the records of their inspection service, the following data for the year 1935:

"In 69 counties a total of 2,635 inspections were reported.

Buildings infested	1,653
Ground infestations	201
No apparent infestations	766
Powder post beetles	15

"It might be concluded that termite-infested buildings represent 62.7 per cent of the total number inspected and reported." This cannot be taken as the actual percentage of infestation for the state since the company representatives, for the most part, are primarily concerned with the infested properties and inspected many houses on request.

"The damage, however, in the infested buildings was found to be serious. In the city of Wichita the termite damage annually exceeds the fire loss, and this is probably true in many other cities in the state.

"Infestation is not uniform over the state. Some areas show slight infestation, and in others it is quite heavy. As yet, complete information regarding the state is not available."

Tarnished plant bugs attained normal numbers in the alfalfa fields in the early spring. Young bugs hatched in the fields about April 22. By October 20, they were more abundant than last year but still scarce. They were rated at 2 for the eastern half of the state.

The wheat stem maggot (Meromyza americana) was more abundant in the state than usual in June. They rated 1 for the central and eastern part of the state

Wheat straw worm. This species has been abundant for several years, but appears to have become scarce during the drought years.

False wireworm. This insect caused slight damage in the fall of 1935, and required some attention in the season of 1936. Some fields near Conway Springs and Wellington were seriously damaged. Four fields near the latter city and six at Anthony were abandoned because of this pest, chiefly **Eleodes opaca** and **E. suturalis.**

In the late fall the false wireworms were abundant in western and southwestern Kansas, but caused little injury to fall-sown wheat. In most localities, sufficient rainfall was received to insure fairly rapid germination of the seed, and therefore little injury occurred. One report of injury was received from Meade County. The insect was rated 4 in Areas 6b, 9, 10a, and 10b, and 3 in Areas 6a and 7.

Wireworms (Melanotus) were observed by Prof. H. R. Bryson to have been less plentiful in March than usual.

Grain weevils were scarce in wheat because there was little wheat left in storage on the farms and not much in local elevators. There is some rather badly infested sorghum seed which was kept over for planting.

Dr. R. T. Cotton of the local field station of the Bureau of Entomology and Plant Quarantine reported that, "Inspection records of carloads of grain arriving in Kan-

sas City, Missouri during the past five years present an excellent picture of the condition of stored grain in the southwestern grain producing area from the standpoint of insect infestation.

"It is interesting to note that there has been a steady decrease in the number of cars infested with weevil, each year during this period. The record for the past year of 1936 is most remarkable since of the 36,585 carloads of grain inspected only 86 were found to be 'weevily'. During no month of the year did the infested cars equal one per cent of the total number inspected, and during July, of the 18,448 cars inspected only 2 were found "weevily'.

The steady decrease in infestation has undoubtedly been due to the succession of dry, hot years experienced in this area. Grain crops have been small and there has been no large carry overs. The newly harvested grain has been low in moisture and during the past season has gone into storage with a moisture content of about 9 per cent. Since investigations have shown that most insect pests of stored grain are unable to breed in grain with a moisture content of less than 10 per cent, the freedom from insect infestation is not surprising."

Poultry lice were plentiful in April and May, and poultry required treating. They were rated at 3 for the state.

White grubs in general caused little injury in 1936, and required no immediate attention. They were less plentiful at Manhattan than one might expect following the beetle year. Dead grubs found in March in the upper six inches of soil appear to have been killed by freezing.

Wheat white grubs caused considerable injury to one field of wheat at Manhattan. A report from Hazelton indicated that the wheat white grub, **Phyllophaga lanceolata,** had cut off wheat plants in several fields in that vicinity. White grubs were also active in strawberrry beds in northeast Kansas. They were rated at 3 in Areas 6b and 9, and 2 in Areas 5 and 6a.

Webworms were present in a few alfalfa fields in July along the Smoky Hill and Kaw River Valleys and a few in the northeast. There was no damage by the insect on account of poor growth of alfalfa in July. They were rated at 1 only for the state.

Summary

The weather during 1936 was characterized by marked drouth during the spring and summer up to the latter part of August and record breaking high temperatures from early June to the latter part of August. It was a poor crop year though a good crop of wheat was harvested and the fall weather was ideal for crops.

The following insects occurred in **outbreak** numbers during 1936; grasshoppers—an unprecedented outbreak with widespread damage which is the chief insect feature of the year, blister beetles, and borers.

The following insects were **scarce or without consequence** during the year; aphids, horse flies, box elder bugs, canker worms, cutworms, chinch bugs, cucumber beetles, hessian fly, mange mites, screwworms, mosquitoes, wheat straw worms, and grain weevils.

The following insects were **more plentiful** than during 1935; ants, blister beetles, borers, cattle lice, chinch bugs, codling moth, crickets, cucumber beetles, grasshoppers, onion plant bugs, rose curculio, squash bugs, strawberry leaf roller, wheat stem maggot, and webworms.

The following insects were **less plentiful** than during 1935; aphids, biting flies on live stock, horse flies, canker worms, cut-worms, house flies, mange mites, screw worms, termites, false wireworms, wireworms, grain weevils, hessian fly and white grubs.

PSEUDOMASARIS OCCIDENTALIS (CRESSON) IN KANSAS (HYMENOPTERA-VESPIDAE)

H. B. HUNGERFORD, Lawrence, Kansas*

Vespid wasps, as a rule, provision their nests with other insects (mass provisions) or feed insects to their larvae from time to time (progressive provisioning). There are, however, some wasps of the family Vespidae that provision their nests with pollen and nectar after the fashion of bees. In North America we have the genus Pseudomasaris which does this. According to Doctor Becquaert[1] there are "14 species in the western United States, from the southern part of British Columbia to Lower California and eastward to Colorado and Texas." The finding of **Pseudomasaris occidentalis** (Cresson) in southeastern Kansas is therefore an interesting new record for the state. This species was described from Texas and so far as I know there are no published notes on its biology.

While European workers have long ago reported that masarid wasps provision their nests with pollen, it has been only within the past ten years that the same habit has been demonstrated for any of our species. Hicks[3] in 1927 found nests of **Pseudomasaris vespoides** (Cresson) attached to rocks and consisting of from 2 to 13 cells. These cells were mass provisioned with pollen and plugged with caps that had cup-shaped depressions.

The depressions, first reported by Davidson[2] in 1913, were thought at the time to be for the purpose of catching rain and softening the material for a more successful emergence from the exceedingly hard cases. In 1929 Hicks[4] recorded the pollen provisioning of **Pseudomasaris edwardsii** (Cresson) which also attaches its extremely hard nest to rocks, and gave additional notes on **Pseudomasaris vespoides** (Cresson). Some nests of the latter species were found attached to plants. Specimens emerged successfully from dry cells. From the nests of **Pseudomasaris edwardsii** (Cresson) he reared a male mutilled. **Chrysis densa** Cresson was reared from nests of both species of Pseudomasaris.

The nest of **Pseudomasaris occidentalis** (Cresson), attached to a fragment of limestone rich in calcite

*Contribution from Department of Entomology, University of Kansas.

crystals, was sent to me by Mr. John Mitchell. He reported the nest to have been found in the Lee Hunt cement quarry on Table Mound, near Independence, Kansas. The exceedingly hard rock-like texture of the nest suggested to him that it was made of cement, yet the cement plant had been closed for thirteen years and he desired some information concerning it. The nest was collected and sent to me on May 4, 1936, and there emerged from the five cells on May 12, 1936, two males and one female of **Pseudomasaris occidentalis** (Cresson)* and two parasites, **Chrysis densa** Cresson*. These insests had no difficulty in making their exit through the very hard stone-like nest. The cells were laid down side by side and their contour visible from above. They are made of limestone sand, some of the calcite grains measuring an eighth of an inch in diameter. Some more finely ground material was used to partially fill the depressions between the cells. The caps did not show the cup-like depression described for **Pseudomasaris vespoides** (Cresson). The two parasitic wasps emerged from the end cells, one of them through the anterior end and the other through a break in the side of the cell caused by loosening the rock fragment from the ledge. Each cell contained at its lower end a mass made up of many pellets. Professor W. C. Stevens, of our Botany Department, examined one of these masses and found it to be made up of pollen grains. We are thus able to report a pollen provisioning wasp for Kansas.

References Cited:

1. Bequaert, J. A New Pseudomasaris from California, with Some Considerations on the Masarid Wasps. Psyche, Vol. XXXVI, pp. 61-88. 1929.

2. Davidson, Anstruther. **Masaria vespoides.** Southern California Academy of Sciences Bull. XII, pp. 17-18. 1913.

3. Hicks, C. H. **Pseudomasaris vespoides,** a Pollen Provisioning Wasp. Can. Ent., Vol. LIX, pp. 75-79. 1927.

4. Hicks, C. H. **Pseudomasaris edwardsii** Cresson, another Pollen-provisioning Wasp with Further Notes on **P.vespoides** (Cresson). Can. Ent., Vol. LXI, pp. 121-125. 1929.

5. Hicks, C. H. Notes on the Pollen-user wasp, **Pseudomasaris edwardsii.** Bull. Southern California Acad. Sci., Vol. XXX, pp. 23-29. 1931.

*Footnote. These were kindly determined for me by Dr. J. Chester Bradley of Cornell University.

INSECTS FOUND IN THE MILLING STREAMS OF FLOUR MILLS IN THE SOUTHWESTERN MILLING AREA.

NEWELL E. GOOD, Assistant Entomologist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture (1)

INTRODUCTION

The adoption of modern methods of insect control has materially changed the relative abundance of certain species infesting the milling streams of flour mills. Formerly the Mediterranean flour moth (**Ephestia kuehnella** Zell.) was the worst insect pest of flour mills, whereas now the flour beetles (**Tribolium** spp.) are the most important. Individual species of flour-mill insects are not equally abundant in all sections of the country, their numbers being influenced by climatic conditions as well as by the methods of control practiced.

In the course of studies relating to insects inhabiting flour mills and stored grain, an opportunity was provided for obtaining data on a large scale regarding the abundance of insects infesting the different mill streams of flour mills in Kansas, Oklahoma, and Missouri. In 1932 and 1934-35, 8-ounce samples were collected monthly from each of 24 elevator boots and other mill streams of 19 selected flour mills in these three States. The insects contained in these samples were sifted out and identified as accurately as was possible without the aid of a microscope, (2) and the numbers of each species and stage, alive and dead, were counted and recorded.(3) The re-

(1). The writer acknowledges his indebtedness to Geo. B. Wagner, of this laboratory, for permission to use data from a monthly flour-mill sampling project which he initiated and in which the writer participated, and for his assistance in the interpretation of certain information presented herein.

(2). A hand lens was frequently used, and specimens that appeared to be of particular interest were sometimes set aside and examined under a binocular microscope. It was easily possible, without a lens, to place practically all the insects in the proper genus and, except in **Tribolium, Laemophloeus, Palorus, Alphitobius,** and a few others, to identify the species.

(3). Information derived from these data, showing the effect of various control measures, or the lack of them, on the total population of insects infesting flour-mill streams, has already been published. See Wagner, G. B., and Cotton, R. T. Factors affecting insect abundance in flour mills. Northwestern Miller, Nov. 20, 1935, pp. 522-523, 4 figures.

cords from 17 of these mills for the period April 1934 to April 1935, inclusive, are tabulated and discussed in this paper. The approximate locations and daily capacities of the mills are shown in the accompanying map (fig. 1).

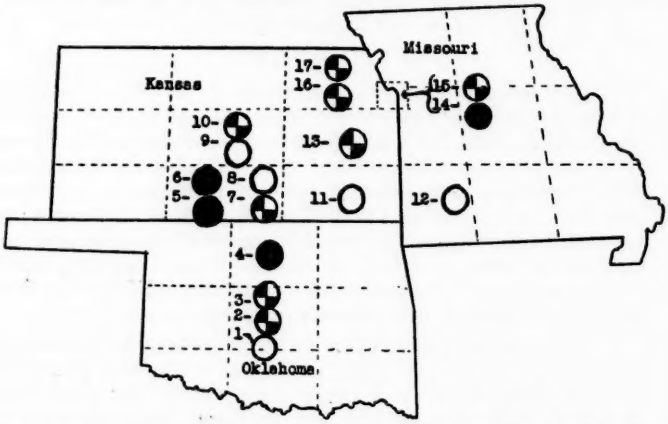


Figure 1.—Map showing location and capacities of flour mills surveyed.
White circles—Mills of less than 1,000 barrels daily capacity.
Black and white circles—Mills of 1,000 to 2,500 barrels daily capacity.
Black circles—Mills of 2,500 or more barrels daily capacity.

RELATIVE ABUNDANCE AND FREQUENCY OF OCCURRENCE

The relative abundance of the six leading groups of insects in all the samples examined is shown in figure 2. The preponderance of the flour beetles (**Tribolium** spp.) is the most striking feature of the chart. The two species (**T. confusum Duv.** and **T. castaneum** Herbst) were not separated when the samples were examined, but it is probable that they are about equally numerous in the territory covered. The flat and the rust-red grain beetles (**Laemophloeus minutus** Oliv. and **L. ferrugineus** Steph.) were second in numbers, followed by the cadelle (**Tenebroides mauritanicus** L.), the lesser grain borer (**Rhizopertha dominica** Fab.), the rice and the granary weevils (**Sitophilus** spp.), and the long-headed flour beetle (**Latheticus oryzae** Waterh.). None of the other species or genera present made up more than

0.22 percent of the total and so cannot be considered of any great economic importance in the region surveyed. Although both **Laemophloeus minutus** and **L. ferrugineus** were present, the former appeared to be considerably more numerous than the latter, while in the genus **Sitophilus** 93.5 percent were identified as **S. oryzae** L. and only 6.5 percent as **S. granarius** L.

ALL OTHERS - 0.72 %
LATHETICUS ORYZAE WATERH. - 0.76 %
SITOPHILUS SPP. - 0.98 %
RHIZOPERTHA DOMINICA FAB. - 1.79 %
TENEBROIDES MAURITANICUS L. - 3.16 %
LAEMOPHLOEUS SPP. - 7.95 %
TRIBOLIUM SPP. 84.63 %

Figure 2.—Percentages of the various species or groups of insects taken in mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-35. (Total, 74,175 insects.)

Almost as striking as the large number of **Tribolium** spp. is the virtual absence of the insect that was once considered the most injurious of all flour-mill pests, **Ephestia kuehniella.**

At least 30 species, distributed among 25 genera, were found in the samples. It is interesting to note that,

of the total of 74,175 specimens collected, all but 112 were beetles; in other words, the Coleoptera made up 99.85 percent of all insects present in flour-mill streams in this region during 1934-35.

The percentage of samples infested with the more important flour-mill insects is shown in figure 3 while table 2 contains data on all of the species concerned. Approximately four-fifths of all the samples collected were infested with from 1 to 1,320 insects. **Tribolium** spp. were found in 78.0 percent of all samples collected, or in 97.1 percent of all samples infested by any insects. **Tenebroides mauritanicus** was present in 17.2 percent, of the samples, **Laemophloeus** spp. in 11.7 percent, and **Sitophilus oryzae** was found in a few more samples than **Rhizopertha dominica.**

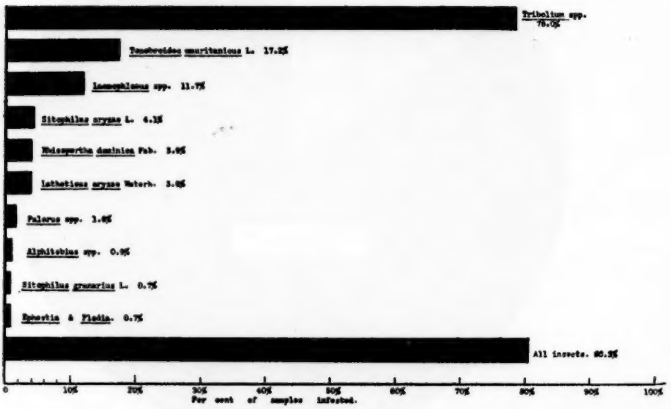


Figure 3.—Percentage of 8-ounce samples from flour-mill streams infested by each of the more important flour-mill insects, as found in 2,367 samples collected from 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-35.

GEOGRAPHICAL DISTRIBUTION

The flour mills discussed in this paper are located within a rather small geographical area, within 200 miles of Independence, Kans. Thus, great variations in the species found, and in their abundance, due to the influence of climatic factors, would hardly be expected. The average annual rainfall ranges from 27.8 to 41.8 inches,

Table 1 -- Abundance of the different species of insects collected in all mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934 and 1935.

Species	Number of specimens found in mill of indicated number and location																		
	7	3	9	11	2	12	8	17	6	5	1	10	14	16	15	4	13		
	South Central: Kansas	Central: Okla-homa	Central: Kansas	eastern: Kansas	Okla-homa	South-western Missouri	South central: Kansas	North eastern: Kansas	South central: Kansas	South central: Kansas	Central Okla-homa	Central: Kansas	Kansas City Area	North-eastern: Kansas	Kansas City Area	North central Oklahoma	East central: Kansas	Total	
Tribolium spp.	15,431	8,520	6,968	4,939	3,629	2,792	3,512	3,209	3,145	2,665	1,893	1,871	1,604	1,497	466	348	297	62,786	
Laemophloeus spp.	3,364	257	91	50	792	316	101	44	73	56	75	482	134	9	0	56	0	5,900	
Tenebroides mauritanicus L.	207	381	52	249	210	459	185	3	34	13	96	66	297	62	0	2	23	2,341	
Rhizopertha dominica Fab.	649	19	66	38	33	120	16	2	9	74	251	27	2	0	3	13	0	1,322	
Sitophilus oryzae L.	109	60	62	76	2	178	53	12	3	19	72	19	3	10	0	0	1	679	
Latheticus oryzae Waterh.	0	332	0	0	5	0	0	0	0	0	227	3	0	1	0	0	0	568	
Palorus spp.	5	0	1	46	0	47	13	0	1	0	26	16	4	2	0	0	0	163	
Oryzaephilus surinamensis L.	0	1	1	0	0	121	5	0	0	0	0	2	0	0	0	0	0	130	
Attagenus piceus Oliv.	2	2	0	0	0	6	1	0	1	0	2	37	0	3	0	0	0	54	
Alphitobius spp.	0	28	0	3	0	8	4	2	0	0	0	2	1	2	0	1	0	51	
Sitophilus granarius L.	0	0	3	1	0	27	4	0	0	0	6	6	0	0	0	0	0	47	
Corrodentia	5	7	0	0	1	0	22	0	0	0	0	0	0	0	0	0	0	35	
Ephestia kuehniella Zell.	11	0	0	0	3	16	0	0	0	1	0	0	0	0	0	0	0	31	
Plodia interpunctella Hbn.																			
Acarina	0	4	0	0	0	0	10	0	0	0	10	0	0	0	0	0	0	24	
Gnathocerus cornutus Fab.	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	14	
Hymenopterous parasites	2	2	1	0	0	0	1	0	1	0	4	0	0	0	0	0	0	11	
Scenopinus spp.	0	0	0	0	0	1	0	0	0	0	1	0	0	3	0	0	0	5	
Pyralis farinalis L.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
Typhaea stercorea L.	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	3	
Carpophilus dimidiatus Fab.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	
Corticaria sp.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	
Corticaria serrata Payk.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
Anthicus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	
Unidentified Coleoptera	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
Unidentified Diptera	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Blattidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Total	19,789	9,815	7,245	5,402	4,675	4,091	3,927	3,272	3,269	2,828	2,866	2,559	2,060	1,589	489	420	321	74,176	
Number of samples collected	193	224	185	98	222	143	182	45	175	219	128	126	121	45	100	138	23	2,367	
Number of samples infested	187	209	157	96	167	132	151	43	120	160	120	104	100	42	39	55	19	1,901	
Percentage of samples infested	96.9	93.3	84.9	98.0	75.2	92.3	83.0	95.6	68.6	73.1	93.8	82.5	82.6	93.3	39.0	39.9	82.6	80.3	
Average number of insects per sample	102.5	42.9	39.2	55.1	21.0	28.6	21.6	72.7	18.7	12.9	20.8	20.2	17.0	35.3	4.7	3.0	14.0	31.3	

the temperature from 54.2 degrees to 60.3 degree F., and the elevation from 740 to 1,550 feet. The mills range in capacity from 300 to 5,800 barrels per day.

The geographical distribution of the insects found is shown in table 1 and figure 4. There is apparently no relation between geographical location within this area and either the total abundance of insects or the abundance of any of the five leading groups: **Tribolium, Laemophloeus, Tenebroides, Rhizopertha**, or **Sitophilus.** Had the two species of **Tribolium** been tabulated separately, there would probably have been a preponderance of **T. castaneum** in Oklahoma and of **T. confusum** in northern Kansas, since they are the predominant forms in these respective sections. However, modern transportation methods have so facilitated the exchange of milling stock between mills located in different parts of the country that infestations of both species may now be found in any section of the country.

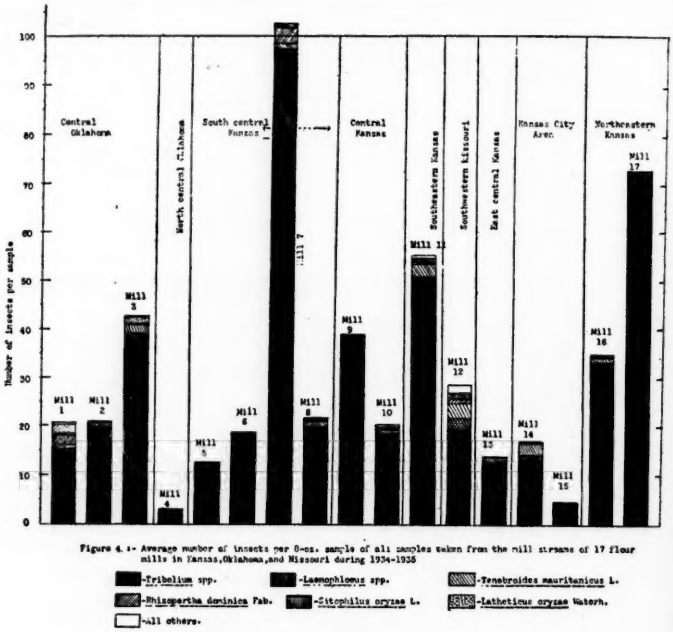


Figure 4.:- Average number of insects per 8-oz. sample of all samples taken from the mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-1935

The only genus of importance showing a distinct variation in abundance due to geographical location is **Latheticus. L. oryzae** was numerous in two mills in central Oklahoma, in each case being third in total numbers, but was scarce or entirely absent in all the other locations. Incidentally, this insect is seldom found in the eastern and northern parts of the United States.

Gnathocerus cornutus Fab. also shows a distinct geographical limitation, but this species, common in the South and in some parts of the East, is almost unknown in the Great Plains. Mill no. 14, in the Kansas City area, was the only one in which this species was found, and only one other record of its occurrence in Kansas is known to the writer.

The saw-toothed grain beetle (**Oryzaephilus surinamensis** L.) was common only in mill no. 12, which is located farther east and in an area that receives more rainfall than any other considered here. This species is seldom present in large numbers in flour mills in Kansas or Oklahoma.

The Lepidoptera **Ephestia, Plodia,** and **Pyralis** were nowhere very numerous, and only in mills nos. 7 and 12, neither of which was fumigated annually, were more than three specimens found.

The abundance of **Palorus** spp. and **Alphitobius** spp. in mill streams appears to be correlated with the location of the elevator boots, since they were taken only in mills in which some of the elevator boots were situated in the basement. These insects, especially the latter, are inhabitants of damp, dark basements and are seldom found elsewhere in the mill.

The records of **Corticaria serrata** Payk. in mill no. 6 and of **Corticaria** sp. and **Anthicus** sp. (4) in mill no. 10 are probably the first records of these species in mill streams in any locality.

The insect population of the mills is closely related to the control measures used. This phase has been thoroughly discussed by Wagner and Cotton (see footnote 3) and will not be gone into further here.

(4). The species in question were determined in the Division of Insect Identification of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

INSECT POPULATIONS IN THE DIFFERENT MILL STREAMS

Relative total infestations. —The average number of insects per sample for the individual mill streams ranged from 9.0 to 61.3, as shown in table 2. The low-grade-flour elevator boot showed the highest average population, with three of the middlings elevator boots, the fourth, second, and fifth, next in order. The predominant insects were the two species of **Tribolium,** which comprised more than 93 percent of the total number of insects in each of the above-named elevator boots, except the second middlings, where a very heavy infestation of **Laemophloeus** spp. was found in one mill. The high population in the low-grade-flour elevator boot is probably due to the position that the low-grade-flour stream occupies in the milling system and the inability to redress such flour properly, coupled with its greater palatability to insects. The same factors influence the population in the fourth and fifth middlings streams, although to a lesser degree.

The mill streams showing the smallest number of insects per sample were the patent-flour rebolt reel stream, the clear-flour rebolt reel stream, the first-break elevator boot, the wheat elevator boot, and the patent-flour elevator boot, in the order named. The patent and the clear-flour rebolt reel streams contained fewer insects mainly because of the rebolting process, the efficiency of which varied greatly in the different mills under observation. The wheat elevator boot showed the lowest relative infestation by **Tribolium** of any mill stream (39 percent), this being readily explained by the fact that **Tribolium** spp. do not breed freely in sound wheat. The first-break elevator boot had more **Tribolium** per sample than the wheat elevator boot, but the numbers of **Sitophilus oryzae** and **Rhizopertha dominica** were materially reduced by the grinding process, and thus the total population in this stream was low.

Relative abundance of the various species. —The relative abundance of the various species in the different mill streams is shown in figure 5. **Tribolium** spp. are more abundant than all other insects combined in each stream except the wheat stream, and even there they are more numerous than any other one genus. They comprise over 95 percent of all insects in the clear, and patent-

Table 2. Insects found in 2,367 eight-ounce samples from 24 different mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934

Species of insect	Stage	Condition	Elevator boots												
			Wheat screenings	Wheat	First break	Second break	Third break	Fourth break	Fifth break	Bran	Shorts	Sizings	First tailings	First middlings	Second middlings	Third middlings
	Adults	Alive	1,542	416	525	976	1,211	1,156	1,116	750	1,422	1,861	1,912	1,941	1,348	1,547
		Dead	301	106	307	277	205	384	220	348	470	477	617	362	360	386
Tribolium spp.	Pupae	Alive	10	5	16	13	17	56	17	29	51	133	89	106	178	134
		Dead	0	0	0	0	0	0	0	0	8	0	0	1	0	3
	Larvae	Alive	634	250	369	820	870	829	560	508	754	1,124	1,149	1,033	1,853	1,243
		Dead	4	3	12	1	8	8	0	12	17	20	20	17	45	16
		Alive	20	100	64	216	271	499	602	262	749	35	85	101	1,353	106
Lasmophloeus spp.	Adults	Dead	5	12	14	22	15	32	5	17	28	4	15	8	164	88
	Pupae	Alive	0	0	0	1	0	0	0	0	0	0	0	50	50	0
	Adults	Alive	2	12	15	17	14	22	7	0	0	8	9	12	3	9
		Dead	8	3	4	1	8	1	2	1	1	2	4	0	1	0
Tenebroides mauritanicus	Larvae	Alive	87	36	82	134	114	130	126	37	41	91	59	41	193	245
		Dead	22	2	2	1	0	5	0	0	1	1	0	0	1	0
Rhizopertha dominica	Adults	Alive	452	261	8	15	2	5	4	2	0	2	2	0	1	1
		Dead	316	233	3	0	0	0	0	8	0	0	0	0	0	0
Sitophilus oryzae	Adults	Alive	78	259	45	8	14	1	0	1	2	0	4	0	0	0
		Dead	120	123	6	2	10	0	0	2	0	1	0	2	0	2
Latheticus oryzae	Adults	Alive	77	56	53	41	18	7	0	3	1	9	0	26	26	20
		Dead	2	7	5	1	1	6	0	1	0	0	0	2	0	3
	Pupae	Alive	0	0	0	0	0	1	0	0	0	3	0	1	0	0
	Larvae	Alive	9	18	42	35	2	5	0	0	2	0	0	0	0	0
Palorus spp.	Adults	Alive	8	58	0	14	7	4	0	0	0	8	2	1	7	4
		Dead	7	2	0	0	1	0	0	0	0	0	0	1	0	0
	Larvae	Alive	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Oryzaephilus surinamensis	Adults	Alive	116	6	0	0	0	1	1	0	1	0	0	0	0	0
		Dead	1	3	0	0	0	0	0	1	0	0	0	0	0	0
Attagenus piceus	Larvae	Alive	47	1	1	0	0	0	0	0	0	0	0	0	0	0
		Dead	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Alphitobius spp.	Adults	Alive	0	3	0	0	2	2	0	8	4	0	1	1	0	0
		Dead	1	0	0	0	0	0	0	0	0	0	0	1	0	0
	Larvae	Alive	7	1	1	0	0	6	0	0	6	0	2	1	2	1
Sitophilus granarius	Adults	Alive	4	27	0	0	0	0	0	0	0	0	0	0	0	2
		Dead	9	1	1	1	0	0	0	1	0	0	0	0	0	0
Corrodentia	Adults	Alive	0	0	9	0	10	8	1	7	0	0	0	0	0	0
Ephestia kuehniella and Plodia interpunctella	Adults	Alive	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Larvae	Alive	0	2	5	5	2	3	0	0	1	4	1	0	0	1
		Dead	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Acarina	Adults	Alive	10	0	4	0	0	0	0	0	10	0	0	0	0	0
Gnathocerus cornutus	Adults	Alive	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Larvae	Alive	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hymenoptera	Adults	Alive	3	4	1	0	1	0	0	0	1	0	0	0	0	0
Scenopinus spp.	Larvae	Alive	1	1	0	1	0	0	0	0	1	0	0	0	1	0
Pyralis farinalis	Larvae	Alive	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Tyrhaea stercorea	Adults	Alive	0	0	0	0	0	1	1	0	0	0	0	0	0	0
		Dead	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Carpophilus dimidiatus	Adults	Alive	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Corticaria sp.	Adults	Dead	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Cortocaria serrata	Adult	Alive	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Anthicus sp.	Adult	Alive	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Unidentified Coleoptera	Larvae	Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Diptera	Adult	Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattidae	Adult	Dead	0	0	0	0	0	1	0	0	0	0	0	0	0	0
TOTAL			3,705	2,016	1,584	2,304	2,810	2,902	2,662	1,977	3,571	3,595	3,971	3,612	5,324	3,830
Number of samples collected			98	106	106	109	108	107	102	89	96	106	110	107	110	108
Number of samples infested			79	82	73	88	91	89	86	64	80	99	103	94	93	91
Percentage of samples infested			82.3	79.1	69.5	80.7	75.0	83.2	84.3	71.9	83.3	93.4	93.6	87.8	85.5	84.3
Number of insects per sample			38.6	19.2	15.1	21.1	23.2	27.1	26.1	22.2	37.2	33.9	36.1	33.8	49.4	35.5

a = Less than 0.01.

mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934 d 1935.

Elevator boots											
Third: break	Fourth: break	Fifth: break	Bran	Shorts	Sizings	First tailings	First middlings	Second middlings	Third middlings	Fourth middlings	
1,211	1,164	1,116	730	1,422	1,661	1,912	1,841	1,386	1,827	2,707	
203	384	220	348	470	477	617	362	360	386	897	
17	84	17	29	61	133	89	106	179	134	184	
0	0	0	0	8	0	0	1	0	3	0	
870	529	560	508	754	1,124	1,149	1,033	1,563	1,245	1,463	
8	8	0	12	17	30	20	17	45	16	25	
271	499	602	262	749	35	85	101	1,353	106	68	
15	32	3	17	28	4	15	8	164	88	23	
0	0	0	0	0	0	0	50	50	0	0	
14	22	7	0	0	8	9	12	3	9	2	
5	1	2	1	1	2	4	0	1	0	4	
114	150	126	37	41	91	59	41	193	246	136	
0	5	0	0	1	1	0	0	1	0	0	
2	5	4	2	0	2	2	0	1	1	1	
0	0	0	8	0	0	0	0	0	0	0	
14	1	0	0	1	2	0	4	0	0	0	
10	0	0	2	0	1	0	2	0	2	0	
18	7	0	3	1	9	0	26	26	20	16	
1	6	0	1	0	0	0	2	0	3	0	
0	1	0	0	0	3	0	1	0	0	0	
2	5	0	0	2	0	0	0	0	0	0	
7	4	0	0	0	8	2	1	7	4	9	
1	0	0	0	0	0	0	1	0	0	0	
10	0	0	0	0	0	0	0	0	0	0	
0	1	1	0	1	0	0	0	0	0	0	
0	0	0	1	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
2	0	0	8	4	0	1	1	0	0	0	
0	0	0	0	0	0	0	1	0	0	0	
0	8	0	0	6	0	2	1	2	1	0	
0	0	0	0	0	0	0	0	0	2	1	
0	0	0	1	0	0	0	0	0	0	0	
10	8	1	7	0	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
2	3	0	0	1	4	1	0	0	1	2	
0	0	0	0	1	0	0	0	0	0	0	
0	0	0	0	10	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	1	0	0	0	0	0	0	
0	0	0	0	1	0	0	0	1	0	0	
0	0	0	0	0	4	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	1	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	1	
0	1	0	0	0	0	0	0	0	0	0	
310	2,902	2,862	1,977	3,571	3,598	3,971	3,612	5,324	3,880	5,328	
108	107	102	89	96	108	110	107	110	108	109	
81	89	85	64	80	99	103	94	94	91	96	
5.0	83.2	84.3	71.9	83.3	93.4	93.6	87.8	85.6	84.3	88.1	
3.2	27.1	26.1	22.2	37.2	33.9	36.1	33.8	48.4	35.6	49.0	

g 1934 d 1936.

Third dding	Fourth middlings	Fifth middlings	Low-grade flour	Clear flour	Patent flour	Clear flour	Patent flour	Reduction roll	Purifiers To sizing roll	To tailing roll	To middling roll	Total number of insects	Total by species	Percentage of total insects	Number of samples infested	Percentage of samples infested	Average number of insects per sample
1,367	2,797	2,641	1,428	1,029	710	225	186	1,147	1,816	1,704		31,881					
386	897	479	280	446	309	170	128	378	559	665		9,838					
134	194	300	111	116	91	48	31	45	90	121		2,000					
3	0	0	1	0	1	1	0	0	9	2		27	62,788	84.65	1,947	78.0	26.5
1,263	1,463	1,214	1,087	1,082	722	238	204	603	1,385	1,308		30,092					
16	25	44	23	44	42	6	5	18	18	62		478					
106	68	11	70	301	36	0	2	8	67	43		5,068					
88	23	8	121	92	26	1	4	2	18	18		721	5,900	7.95	277	11.7	2.5
0	0	0	0	0	0	0	0	0	0	0		101					
9	2	9	0	5	31	0	0	1	0	2		178					
0	4	0	0	1	0	0	0	0	0	0		38					
245	126	165	35	194	35	7	1	24	22	29		2,086	2,341	5.16	408	17.2	1.0
0	0	1	1	1	1	0	0	0	0	0		39					
1	1	0	0	1	0	0	0	2	0	0		799					
0	0	0	0	1	0	0	0	1	1	0		563	1,322	1.78	95	3.9	0.56
0	0	1	0	0	0	0	0	0	0	0		411	679	0.92	98	4.1	0.29
2	0	0	0	0	0	0	0	0	0	0		266					
20	16	2	0	23	20	3	5	0	1	2		409					
3	0	0	0	9	2	0	0	0	0	0		39	566	0.76	91	3.8	0.24
0	0	0	0	0	0	0	0	0	0	0		8					
0	0	0	0	0	0	0	0	0	0	0		115					
4	9	3	0	0	6	0	0	6	1	0		138					
4	0	2	0	0	0	0	0	0	1	1		18	163	0.22	37	1.6	0.07
0	0	0	0	0	0	0	0	0	0	0		10					
0	0	0	0	0	0	0	0	0	0	0		126					
0	0	0	0	0	0	0	0	0	0	0		6	130	0.18	9	0.4	0.06
0	0	0	0	0	0	0	0	0	0	0		52					
0	0	0	0	0	0	0	0	0	0	0		2	54	0.07	11	0.5	0.02
0	0	1	0	0	0	0	0	0	0	0		22					
0	0	0	0	0	0	0	0	0	0	0		2	51	0.07	22	0.9	0.02
1	0	0	0	0	0	0	0	0	0	0		27					
2	1	0	0	0	0	0	0	0	0	0		34	47	0.06	16	0.7	0.02
2	1	0	0	0	0	0	0	0	0	0		13					
0	0	0	0	0	0	0	0	0	0	0		26	26	0.06	8	0.3	0.01
0	0	0	0	0	1	0	0	0	0	0		2					
0	0	0	0	0	0	0	0	1	0	0		1					
1	2	0	0	0	0	0	0	1	0	0		27	31	0.04	17	0.7	0.01
1	0	0	0	0	0	0	0	0	0	0		1					
0	0	0	0	0	0	0	0	0	0	0		24	24	0.03	3	0.1	0.01
0	0	0	0	0	0	0	0	0	0	0		9					
0	0	0	0	0	5	0	0	0	0	0		5	14	0.02	2	0.1	(a)
0	0	0	0	0	0	0	0	1	0	0		11	11	0.01	7	0.3	(a)
0	0	0	0	0	0	0	0	0	0	0		5	5	(a)	5	0.2	(a)
0	0	0	0	0	0	0	0	0	0	0		4	4	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	0		2					
0	0	0	0	0	0	0	0	0	0	0		1	3	(a)	3	0.1	(a)
0	0	0	0	0	0	0	0	0	0	0		2	2	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	0		2	2	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	0		1	1	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	0		1	1	(a)	1	0.04	(a)
0	1	0	0	0	0	0	0	0	0	0	1	1	1	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	0	0	1	1	(a)	1	0.04	(a)
830	5,338	4,902	3,557	3,344	1,988	697	586	2,236	3,983	3,956		74,176	74,176	100	1,901	80.31	31.94
108	109	108	58	106	106	54	62	100	97	99		2,327	—	—	—	—	—
91	96	97	52	85	76	31	34	70	75	79		1,801	—	—	—	—	—
84.3	88.1	89.8	89.7	80.0	71.7	48.4	54.8	70.0	77.3	79.8		80.3	—	—	—	—	—
55.6	49.0	45.4	81.3	31.5	19.3	10.9	9.0	22.4	41.1	40.0		31.3	—	—	—	—	—

flour rebolt reel streams, fourth and fifth middlings, first tailings and sizings elevator boots, and all three of the purifier streams sampled, and make up over 84 percent of the total for all mill streams.

WHEAT SCREENINGS ELEVATOR BOOT
WHEAT ELEVATOR BOOT
1ST BREAK ELEVATOR BOOT
2ND BREAK ELEVATOR BOOT
3RD BREAK ELEVATOR BOOT
4TH BREAK ELEVATOR BOOT
5TH BREAK ELEVATOR BOOT
BRAN ELEVATOR BOOT
SHORTS ELEVATOR BOOT
SIZING ELEVATOR BOOT
1ST TAILINGS ELEVATOR BOOT
1ST MIDDLINGS ELEVATOR BOOT
2ND MIDDLINGS ELEVATOR BOOT
3RD MIDDLINGS ELEVATOR BOOT
4TH MIDDLINGS ELEVATOR BOOT
5TH MIDDLINGS ELEVATOR BOOT
LOW GRADE FLOUR ELEVATOR BOOT
CLEAR FLOUR ELEVATOR BOOT
PATENT FLOUR ELEVATOR BOOT
CLEAR FLOUR REBOLT REEL STREAM
PATENT FLOUR REBOLT REEL STREAM
PURIFIER NO.1 TO SIZING ROLL
PURIFIER NO.3 TO TAILING ROLL
PURIFIER 7TH MIDDLINGS ROLL
AVERAGE - ALL STREAMS
0 5 10 15 20 25 30 35 40 45 50 55 60
AVERAGE NUMBER OF INSECTS PER 8OZ. SAMPLE
TRIBOLIUM SPP.
LAEMOPHLOEUS SPP.
TENEBROIDES MAURITANICUS L.
RHIZOPERTHA DOMINICA FAB.
SITOPHILUS SPP.
LATHETICUS ORYZAE WATERH.
ALL OTHERS

FIGURE 5 - AVERAGE NUMBER OF INSECTS PER 8 OUNCE SAMPLE AND PROPORTIONS OF DIFFERENT SPECIES FOUND IN 2,367 SAMPLES FROM THE DIFFERENT MILL STREAMS OF 17 FLOUR MILLS IN KANSAS, OKLAHOMA AND MISSOURI DURING 1934-1935

Rhizopertha dominica and **Sitophilus oryzae** are very numerous in wheat and wheat screenings and almost completely absent after the third and fourth break. This, of course, would be expected, since these are grain-feeding, not flour-feeding, insects. The predominance of **S. oryzae** over **S. granarius** is also worthy of note. The total number of all these insects should probably be much higher than indicated here, because only adults were counted, it being impossible to see the larvae and pupae

within the grain.

Laemophloeus spp., although numerous throughout, show apparently inconsistent variations in numbers in certain mill streams, especially in the second middlings and shorts. These inconsistencies can be explained by the fact that a few samples containing unusually large numbers of these insects were taken from elevator boots which contained stock that was slightly out of condition.

Tenebroides mauritanicus is evenly distributed throughout all the mill streams, and does not appear in excessive numbers in any one stream. This species was third in total numbers and second only to **Tribolium** in the percentage of samples infested. Because of its size and its injury to bolting cloth, it is probably exceeded only by **Tribolium** in the quantity of damage done.

Of the other insects present, **Latheticus oryzae, Palorus ratzeburgi** Wissm., **P. subdepressus** Woll., **Alphitobius diaperinus** Panz., **A. piceus** Oliv., and **Ephestia kuehniella** were fairly evenly distributed throughout the different mill streams, although none of them were very abundant in any one stream. **Oryzaephilus surinamensis** and larvae of **Attagenus piceus** Oliv. were moderately abundant in wheat screenings, less so in wheat, and practically absent from other mill streams.

SEASONAL FLUCTUATIONS IN POPULATIONS

Insects inhabiting flour mills are much less influenced by seasonal and climatic changes than are most insects. This is due to the uniform conditions of temperature and moisture that prevail in the milling streams of flour mills. Modern mills, heated and sometimes even air-conditioned, and frequently operating 24 hours a day over long periods, offer almost ideal conditions for the continuous breeding and development of insect pests.

The seasonal fluctuation in the general insect populations in flour mills as influenced by the various factors that affect it has been discussed by Wagner and Cotton (see reference in footnote 3).

The proportions that each species or group comprises of the total insect population during each month of the year are illustrated in figure 6. The seasonal fluctuation in total insect population is not shown. No collections were made during February, and the November and December collections must be considered as one,

since some of the mills were sampled in November and the rest in December. For this reason the proportions shown for February and for November-December are approximated. The larvae and pupae of **Tribolium** are separated from the adults to illustrate their seasonal distribution. **Tribolium** adults comprised their greatest percentage (74.6) of the total in the November-December collections and their lowest percentage (36.1) in the following month of January, while **Tribolium** larvae and pupae made up their greatest percentage (40.5) in April 1935 followed by April 1934 (37.3), and their lowest percentage (16.9) in November-December. This would

Table 3 -- Seasonal fluctuation in the populations of the insects infesting the milling streams of flour mills, as found in samples from 17 mills in Kansas, Oklahoma, and Missouri.

Species	Stage	Condition	1934 April	May	June	July	August	September	October	November and December	1935 January	March	April	Total
Tribolium spp.	Adults	Alive:	1,676	3,262	2,827	2,481	3,945	2,902	5,246	1,722	1,956	3,039	2,493	31,361
		Dead:	601	607	997	989	1,590	866	1,525	698	807	820	338	9,830
	Pupae	Alive:	259	198	164	53	173	468	241	37	54	178	175	2,000
		Dead:	1	5	0	0	2	6	7	6	0	0	0	27
	Larvae	Alive:	1,223	1,662	1,175	1,307	2,517	2,385	2,485	472	2,235	2,377	2,034	20,092
		Dead:	31	55	88	102	74	81	20	33	8	5	1	478
Lasioplocus spp.	Adults	Alive:	263	701	348	111	462	137	264	76	1,172	1,449	65	5,068
		Dead:	0	242	159	26	199	79	6	8	2	10	0	731
	Pupae	Alive:	0	0	0	0	1	0	0	0	0	100	0	101
		Dead:	2	16	7	6	18	41	24	7	16	26	15	178
Tenebroides mauritanicus L.	Adults	Alive:	1	2	4	2	10	8	5	5	0	1	0	38
		Dead:	80	272	128	107	222	191	286	45	310	247	198	2,086
	Larvae	Alive:	0	0	4	0	9	22	3	1	0	0	0	39
		Dead:	17	4	22	16	236	133	126	49	136	6	14	759
Rhizopertha dominica Fab.	Adults	Alive:	2	3	7	1	248	221	24	0	57	0	0	563
		Dead:	19	52	2	8	18	37	116	26	0	79	56	411
Sitophilus oryzae L.	Adults	Alive:	76	14	4	1	73	62	22	6	0	2	8	268
		Dead:	0	6	9	16	51	129	137	22	8	10	21	409
Lathetious oryzae Waterh.	Adults	Alive:	0	0	0	3	10	14	6	0	3	3	0	39
	Pupae	Alive:	0	0	0	0	1	4	0	0	0	0	0	5
	Larvae	Alive:	0	0	0	0	35	78	0	0	0	0	0	113
		Alive:	9	9	14	2	4	14	66	19	0	2	9	138
Palorus spp.	Adults	Alive:	0	0	2	0	1	8	4	0	0	0	0	15
	Larvae	Alive:	0	0	0	0	0	0	10	0	0	0	0	10
		Alive:	0	130	0	1	0	2	0	2	0	0	0	135
Oryzaephilus surinamensis L.	Adults	Alive:	0	0	0	0	2	3	0	0	0	0	0	5
		Alive:	0	2	0	0	34	8	2	5	0	0	1	52
Attagenus piceus Oliv.	Larvae	Alive:	0	2	0	0	0	1	1	0	0	0	0	2
		Alive:	0	2	0	6	1	0	5	4	0	0	4	22
Alphitobius spp.	Adults	Alive:	0	0	1	0	0	1	0	0	0	0	0	2
		Alive:	1	1	0	3	0	3	14	0	0	1	4	27
Sitophilus granarius L.	Adults	Alive:	0	27	0	0	0	1	1	0	0	3	2	34
		Dead:	1	0	0	0	4	3	4	0	0	0	1	13
Corrodentia	Adults	Alive:	0	0	0	0	34	1	0	0	0	0	0	35
Ephestia kuehniella Zell. and Plodia interpunctella Hbn.	Adults	Alive:	0	1	0	0	0	0	0	0	0	1	0	2
		Dead:	0	1	0	0	0	0	0	0	0	0	0	1
	Larvae	Alive:	1	10	1	5	0	0	5	0	6	0	1	27
		Dead:	0	1	0	0	0	0	0	0	0	0	0	1
Acarina	Adults	Alive:	0	0	0	0	14	10	0	0	0	0	0	24
Gnathocerus cornutus Fab.	Adults	Alive:	0	0	0	0	0	0	0	0	0	8	3	9
	Larvae	Alive:	0	0	0	0	0	0	0	0	0	5	0	5
Hymenoptera	Adults	Alive:	0	0	0	0	4	6	0	0	0	0	0	10
		Dead:	0	0	0	0	0	1	0	0	0	0	0	1
Scenopinus sp.	Larvae	Alive:	0	0	0	0	0	4	0	1	0	0	0	5
Pyralis farinalis L.	Larvae	Alive:	4	0	0	0	0	0	0	0	0	0	0	4
		Alive:	0	0	0	0	2	0	0	0	0	0	0	2
Typhaea stercorea L.	Adults	Dead:	0	0	0	0	1	0	0	0	0	0	0	1
Carpophilus dimidiatus Fab.	Adults	Alive:	0	0	0	0	0	0	0	0	0	0	0	2
Cortinaria spp.	Adults	Dead:	0	0	0	0	2	0	0	0	0	0	0	2
Cortinaria serrata Payk.	Adults	Alive:	0	0	0	0	0	1	0	0	0	0	0	1
Anthicus sp.	Adults	Alive:	0	0	0	0	1	0	0	0	0	0	0	1
Unidentified Coleoptera	Larvae	Dead:	0	0	0	0	0	1	0	0	0	0	0	1
Unidentified Diptera	Adults	Dead:	0	0	0	0	0	1	0	0	0	0	0	1
Blattidae	Adults	Dead:	0	0	0	0	0	0	0	1	0	0	0	1
Total			6,060	7,495	6,903	5,244	9,998	7,913	10,483	3,246	6,270	8,070	5,465	76,175
Number of samples collected			83	158	130	196	333	306	362	173	224	300	206	2,367
Number of samples infested			77	137	116	145	247	215	234	138	166	238	186	1,901
Percentage of samples infested			92.8	86.4	89.2	74.4	74.2	70.3	89.3	79.8	75.0	79.3	90.3	80.31
Number of insects per sample			46.9	48.4	45.9	26.9	30.0	25.9	39.9	18.8	28.0	26.9	26.5	31.34

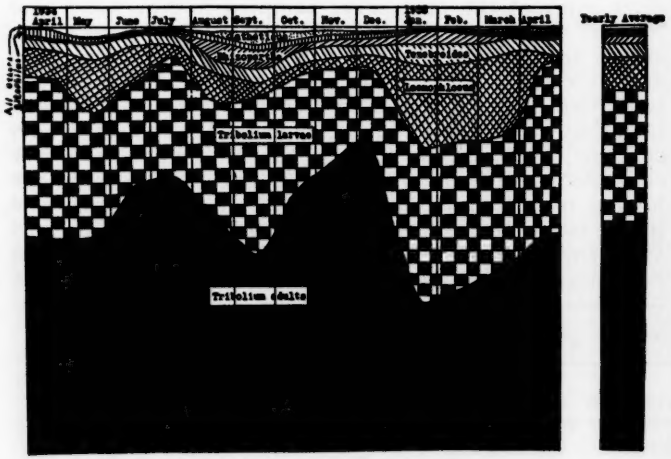


Figure 6.—Seasonal variations in the relative abundance of the different species of insects infesting the milling streams of flour mills, as found in samples from 17 mills in Kansas, Oklahoma, and Missouri during 1934-35.

be expected, since breeding is at its lowest ebb during the winter months and highest in the spring. **Laemophloeus** spp. were most numerous during January and March (18.7 and 19.3 percent respectively) but, curiously enough, least numerous in April 1935 (1.6 percent). The large number of this species in January and March has been explained above. **Tenebroides mauritanicus** shows in its seasonal abundance the same uniformity that characterizes its geographical distribution and its distribution throughout the different mill streams. This appears to be due to a high reproductive potential coupled with great adaptability but tempered by the presence of some controlling factor, probably the extremely pugnacious nature of the species so that their constant killing of each other prevents more than a few from ever being present in one place at one time.

Latheticus oryzae and, to a lesser extent, **Rhizopertha dominica** show a seasonal distribution, being abundant during the summer and fall but scarce in the winter and spring. The fact that these are normally southern species requiring rather high temperatures may have a bearing on this point.

REPRINT PRICES

JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY.

pp.	25 cop.	50 cop.	100 cop.	500 cop.
1— 2	$ .50	$ .75	$ 1.40	$ 6.50
3— 4	1.00	1.75	2.80	11.00
5— 8	1.40	2.80	5.60	20.00
9—12	2.00	4.00	8.00	32.00
13—16	2.50	5.00	9.00	36.00
17—20	3.00	6.00	10.00	40.00
21—24	3.50	7.00	11.00	44.00
25—28	4.00	8.00	12.00	48.00
29—32	4.50	9.00	13.00	52.00
Tables—for setting up—$1.75 per page.				
Covers	—	—	2.50	7.50

Charges for postage or express on carriage of reprints are extra.

PRICES OF BACK VOLUMES

Volume 1 ..... $2.00
Volumes 2 to 8 ..... 1.00
Volume 8 ..... 1.50

Send your subscriptions for back volumes or numbers to the Secretary-Treasurer, Department of Entomology, K. S. C., Manhattan, Kansas.

CONTENTS OF THIS NUMBER

THE SIXTH ANNUAL INSECT POPULATION SUMMARY OF KANSAS COVERING THE YEAR 1936—ROGER C. SMITH and E. G. KELLY 113

PSEUDOMASARIS OCCIDENTALIS (CRESSON) IN KANSAS (HYMENOPTERA-VESPIDAE)—H. B. HUNGERFORD . 133

INSECTS FOUND IN THE MILLING STREAMS OF FLOUR MILLS IN THE SOUTHWESTERN MILLING AREA—NEWELL E. GOOD 135

JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY

Publication Office, 119 South Main Street, McPherson, Kansas.

A quarterly journal published in January, April, July and October devoted to Entomology in the Western Mississippi Basin and the proceedings of the Kansas Entomological Society.

Manuscripts for publication may be sent to any of the publication committee.

The Kansas Entomological Society does not make exchanges since the Society does not maintain a library.

Subscription to the Journal must be paid in advance. The subscription rate is so low that second notices are not ordinarily sent out.

Payment of Canadian or other foreign subscriptions and bills must be made by International Postal Money Order or by a draft on a New York bank and payable in U. S. A. dollars.

Subscribers are urged to give us their full cooperation in these matters.

Subscriptions should be sent to the office of Publication, 119 South Main Street, McPherson, Kansas.

Subscription in the U. S. A.,	**$1.50 per year**	**Single Copy**
Canadian or foreign subscriptions,	**1.75 per year**	**60 cents**

KANSAS ENTOMOLOGICAL SOCIETY

Vice-President, L. C. Woodruff, University of Kansas, Lawrence.

Secretary-Treasurer, H. H. Walkden, Manhattan.

Volume 10, No. 4, October, 1937. **Mailed November 1, 1937.**